ARTICLE

Health-Related Quality of Life of Children and Adolescents With Type 1 or Type 2 Diabetes Mellitus

SEARCH for Diabetes in Youth Study

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Objective: To examine the associations between demographic and diabetes management variables and the health-related quality of life (HRQOL) of youths with type 1 or type 2 diabetes mellitus (DM).

Design: Cross-sectional study.

Settings: Selected populations in Ohio, Washington, South Carolina, Colorado, Hawaii, and California; health service beneficiaries in 3 American Indian populations; and participants in the Pima Indian Study in Arizona.

Participants: Two thousand four hundred forty-five participants aged 8 to 22 years in the SEARCH for Diabetes in Youth Study.

Main Outcome Measure: Pediatric Quality of Life Inventory scores.

Results: Among youths with type 2 DM, HRQOL was lower compared with those with type 1. Among those with type 1 DM, worse HRQOL was associated with a primary insurance source of Medicaid or another government-funded insurance, use of insulin injections vs an insulin pump, a hemoglobin A_{1c} value of at least 9%, and more comorbidities and diabetes complications. There was a significant age × sex interaction, such that, in older groups, HRQOL was lower for girls but higher for boys. For youths with type 2 DM, injecting insulin at least 3 times a day compared with using an oral or no diabetes medication was associated with better HRQOL, and having 2 or more emergency department visits in the past 6 months was associated with worse HRQOL.

Conclusions: Youths with types 1 and 2 DM reported HRQOL differences by type of treatment and complications. The significant age × sex interaction suggests that interventions to improve HRQOL should consider gender differences in diabetes adjustment and management in different age groups.

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Children and adolescents with diabetes mellitus (DM) face unique challenges. In addition to the usual stressors encountered in childhood and adolescence, youths with DM encounter physical and social limitations and issues associated with the management of their condition.[1-7] Conflicts over diabetes management may also lead to more stressful parent-adolescent relations.[8,9] A major goal of diabetes care is to enable individuals to manage their condition without experiencing diminished quality of life.

Children and adolescents who show better adjustment to their DM early after diagnosis have been found to have better long-term outcomes.[10,11] Younger age has also been associated with better self-monitoring of glucose levels and better quality of life.[12,13] During adolescence, competing social, school, and other demands may negatively affect adherence to treatment regimens.[1,14-16] Parental involvement in diabetes management may also diminish.[13] Several studies suggest that girls are more likely than boys to have poorer metabolic control owing to poor adherence to treatment.[1,17] In addition, adolescents with poorer metabolic control may experience greater psychological morbidity[18-20] and reduced health-related quality of life (HRQOL).[1,12,21]

Recently, the incidence of type 2 DM in children and adolescents has been increasing.[22,23] These youths have been understudied, and we know little about the HRQOL impact of the diagnosis and treatment of type 2 DM over time, or how the HRQOL of children with types 1 and 2 DM may differ or be similar.

The purpose of this study was to examine how demographic and diabetes-

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related variables are associated with the HRQOL of children, adolescents, and young adults by diabetes types 1 and 2, using baseline data from the SEARCH for Diabetes in Youth Study. Based on previous research in pediatric diabetes, we hypothesized that girls and youths of both sexes experiencing diabetes management difficulties would have lower HRQOL, regardless of diabetes type.

METHODS

SAMPLE AND PROCEDURES

The SEARCH for Diabetes in Youth Study is a multicenter, population-based ascertainment study of youths with nongestational, clinically diagnosed DM who were younger than 20 years at the end of 2001 (prevalent cohort) and youths newly diagnosed as having DM from 2002 forward (incident cohorts).[24] Diabetes cases were identified from geographically defined populations in Ohio, Washington, South Carolina, and Colorado; from health plan enrollees in Hawaii and California; among health service beneficiaries in 3 American Indian populations; and from participants in the Pima Indian Study in Arizona.[25] Diabetes cases were considered valid if diagnosed by a health care provider.

Before protocol implementation, the study was approved by the local institutional review board for each population. Data collection complied with Health Insurance Portability and Accountability Act regulations. Identified youths completed a survey by mail to collect information on age at diagnosis, treatment history, and demographics (race/ethnicity and sex). Youths who returned the survey, excluding those whose diabetes was secondary to another health condition, were then invited to a study visit. Written informed consent was obtained from participants older than 18 years or from a parent or guardian of minor children. Written assent was also obtained from minor participants as governed by the local institutional review board. During the study visit, additional clinical, demographic, and quality-of-life information was collected by participant interviews, and blood was drawn to measure levels of diabetes autoantibodies, fasting glucose, c-peptide, and lipids. A physical examination was completed to measure systolic and diastolic blood pressure, height, weight, and waist circumference.

The SEARCH study identified 7539 registered cases of DM, of which 3215 had had a baseline clinic visit at the time of these analyses. Analyses were further restricted to youths aged 8 to 22 years at the time of the study visit in whom DM was prevalent in 2001 or incident in 2002 and 2003, and who had a diabetes duration of at least 12 months (n=2569). The HRQOL measures were not completed by 124 participants (4.8%), resulting in a final sample size of 2445.

OUTCOME MEASURES

SEARCH Diabetes Health Questionnaire

The SEARCH Diabetes Health Questionnaire assessed clinical presentation at diabetes onset, diagnostic laboratory testing, previous and concurrent medical conditions (eg, thyroid and/or kidney disorders, asthma, and hypertension), diabetes treatment, concomitant medications, status of diabetes care, diabetes-related emergencies (eg, severe hypoglycemia and diabetes ketoacidosis), number of acute health events in the preceding 6 months (eg, emergency department visits and hospitalizations, regardless of cause), types of health care providers, household resources to assist in diabetes management, type of health insurance, and demographic items.

Pediatric Quality-of-Life Inventory

The Pediatric Quality of Life Inventory (PedsQL) is a 23-item, multidimensional quality-of-life instrument designed for use with children.[26] Child self-report forms are available by age group (5-7, 8-12, 13-18, and ≥19 years). The form contains the following 5 subscales: physical health, psychosocial health, emotional functioning, social functioning, and school functioning. A total score and individual subscale scores can be calculated. Acceptable levels of reliability and validity for the PedsQL have been reported in both healthy and chronically ill children.[27,28] Scores range from 0 to 100, and higher PedsQL scores indicate better levels of functioning and HRQOL.

TYPE OF DM

Type of DM was that assigned by the participant's health care provider. Youths with DM types T1a, T1b, and T1 were combined into a single category, type 1 (n=2188); those with DM type T2 or maturity onset diabetes of the young (n=3) were combined into another single category, type 2 (n=257). Cases labeled as hybrid (n=5) or unknown (n=13) or for which the physician type was missing (n=2) were excluded.

HEMOGLOBIN A_{1c}

Blood samples obtained during the study visit were processed locally and shipped on ice for analysis to the Northwest Lipid Laboratory, University of Washington at Seattle. An ion exchange unit (Variant II; Bio-Rad Diagnostics, Hercules, California) quantified the hemoglobin A_{1c} (HbA_{1c}) levels. The reference range for normal HbA_{1c} values was 3.9% to 6.1% (to convert HbA_{1c} values to a proportion of 1.0, multiply by 0.01). Optimal HbA_{1c} goals for children are less than 8% for those aged 8 to 12 years, less than 7.5% for those aged 13 to 18 years, and less than 7% for those 18 years and older.[29]

BODY MASS INDEX *z* SCORE

Height was measured using a stadiometer. Weight was measured in kilograms using an electronic scale. The weight measurement was divided by the height measurement (in meters squared) to calculate body mass index (BMI). A BMI *z* score was calculated by comparing each participant's BMI measure with age- and sex-specific standards published by the National Center for Health Statistics.[30] These standards enabled each participant's deviation from the reference value to be calculated in terms of a normalized standard deviation score (SDS or *z* score). Using the 2000 Centers for Disease Control and Prevention US growth charts, participants were also classified as being overweight or at risk for overweight if their age- and sex-specific BMI was equal to or above the 95th or the 85th percentile, respectively.[30]

STATISTICAL ANALYSES

Demographic and diabetes-related variables were examined as correlates of HRQOL by type 1 and type 2 DM in cross-sectional analyses. Dependent variables were the total score of the PedsQL (primary outcome) and the PedsQL subscale scores (secondary outcomes). The demographic variables examined were sex, race/ethnicity, age, highest level of parent education, and type of health insurance. The clinical and diabetes management-related variables included the BMI *z* score, duration of diabetes, type of diabetes treatment, HbA_{1c} level, number of comorbid conditions, and the numbers of hypoglycemic events, emergency department visits, and hospitaliza-

Table 1. Demographic and Clinical Characteristics of the SEARCH Participants by Diabetes Type[a]

Characteristics	Type 1 DM (n=2188)	Type 2 DM (n=257)	*P* Value[b]
Sex			
Male	1080 (49.4)	90 (35.0)	<.001
Female	1108 (50.6)	167 (65.0)	
Race/ethnicity			
American Indian	20 (0.9)	59 (23.9)	<.001
Asian or Pacific Islander	51 (2.4)	13 (5.3)	
African American	149 (7.0)	82 (33.2)	
Hispanic	279 (13.1)	52 (21.1)	
Non-Hispanic white	1633 (76.6)	41 (16.6)	
Age at study visit, y			
8-12	793 (36.3)	16 (6.2)	<.001
13-18	1098 (50.2)	154 (59.9)	
≥19	296 (13.5)	87 (33.9)	
Mean (SD) age, y	14.6 (3.6)	17.5 (2.8)	<.001
Parent education			
<High school graduate	93 (4.3)	43 (17.3)	<.001
High school graduate	359 (16.5)	76 (30.5)	
Some college or technical school	715 (32.9)	80 (32.1)	
≥Bachelor's degree	1007 (46.3)	50 (20.1)	
Health insurance			
Private	1783 (81.8)	124 (49.2)	<.001
Medicaid/other government-funded program	319 (14.6)	88 (34.9)	
Other	39 (1.8)	28 (11.1)	
None	39 (1.8)	12 (4.8)	
BMI category			
Normal weight (<85th percentile)	1417 (65.8)	37 (14.9)	<.001
At risk of overweight (85th-95th percentile)	484 (22.5)	42 (16.9)	
Overweight (>95th percentile)	254 (11.8)	169 (68.2)	
Mean (SD) BMI *z* score	0.64 (0.87)	1.81 (0.81)	<.001
Mean (SD) duration of diabetes, mo	73.3 (47.1)	40.6 (22.3)	<.001
HbA_{1c} level, %			
<7	219 (10.8)	89 (36.6)	<.001
7-9	1173 (58.0)	52 (21.4)	
>9	629 (31.1)	102 (42.0)	
Mean (SD) HbA_{1c} level, %	8.6 (1.6)	8.7 (2.7)	.59
Insulin treatment			
Oral or no diabetes medications	14 (0.6)	135 (56.7)	<.001
Insulin <3 times/d	634 (29.1)	71 (29.8)	
Insulin ≥3 times/d	1042 (47.8)	30 (12.6)	
Insulin pump	491 (22.5)	2 (0.8)	
No. of comorbid conditions			
None	1546 (70.7)	121 (47.1)	<.001
1	528 (24.1)	90 (35.0)	
2	97 (4.4)	37 (14.4)	
≥3	17 (0.8)	9 (3.5)	
No. of hypoglycemic episodes in past 6 mo			
0	1922 (88.1)	247 (96.9)	<.001
1	140 (6.4)	6 (2.4)	
≥2	120 (5.5)	2 (0.8)	
No. of hospitalizations in past 6 mo			
0	2033 (93.1)	223 (87.1)	<.001
1	112 (5.1)	19 (7.4)	
≥2	39 (1.8)	14 (5.5)	
No. of ED visits in past 6 mo			
0	1740 (79.7)	181 (70.7)	<.001
1	336 (15.4)	38 (14.8)	
≥2	108 (5.0)	37 (14.5)	

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); DM, diabetes mellitus; ED, emergency department; HbA_{1c}, hemoglobin A_{1c}.

[a] Unless otherwise indicated, data are expressed as number (percentage) of participants.

[b] Calculated from a χ^2 test for categorical variables and a *t* test for continuous variables.

tions in the preceding 6 months. None of the correlations among these covariates and with the PedsQL total score exceeded 0.50.

Demographic and diabetes-related characteristics by diabetes type were summarized as frequencies and percentages for categorical variables and as means and standard deviations for

Table 2. PedsQL Total and Subscale Scores by Diabetes Type[a]

PedsQL Scores[b]	Type 1 DM (n = 2188) Cronbach α	Type 1 DM (n = 2188) Mean (SD)	Type 2 DM (n = 257) Cronbach α	Type 2 DM (n = 257) Mean (SD)
Total	0.88	82.2 (12.1)	0.85	76.7 (14.1)
Physical health subscale	0.79	86.6 (12.6)	0.71	81.4 (14.7)
Psychosocial health subscale	0.85	79.8 (13.7)	0.82	74.2 (15.8)
Emotional functioning subscale	0.73	75.9 (18.4)	0.71	68.3 (21.0)
Social functioning subscale	0.80	88.2 (15.2)	0.81	83.9 (18.3)
School functioning subscale	0.89	75.2 (17.0)	0.90	70.5 (20.3)

Abbreviations: DM, diabetes mellitus; PedsQL, Pediatric Quality of Life Inventory.
[a] For the comparison of type 1 and type 2 DM, the P value for the difference between means was $<.001$ for the PedsQL total score and all subscale scores.
[b] Scores range from 0 to 100.

continuous variables. Multiple linear regression models were fit to look at the simultaneous effects of these demographic and diabetes-related characteristics on the PedsQL total and subscale scores by diabetes type.

RESULTS

Compared with youths with type 1 DM, those with type 2 tended to be female, African American, Hispanic, or American Indian, and in their adolescent years (**Table 1**). The parents of youths with type 2 DM also had less education and were more likely to receive Medicaid or another government-funded health insurance program or to have no health insurance, compared with parents of youths with type 1. Youths with type 2 DM were also more likely to be taking oral medications, whereas youths with type 1 were more likely to be injecting insulin daily.

Youths with type 2 DM had higher BMI z scores and had a diabetes duration of approximately 3 years vs 6 years for the type 1 participants. Youths with type 2 DM were also more likely to have an HbA_{1c} level of less than 9%, although the mean HbA_{1c} value did not differ by diabetes type. Youths with type 2 DM were less likely to have had a hypoglycemic episode in the past 6 months; however, about 53% reported 1 or more comorbid conditions, compared with 29% of the participants with type 1. Emergency department visits and hospitalizations in the past 6 months were also higher for youths with type 2.

The Cronbach α coefficients for the PedsQL total scores were calculated by age group, sex, and diabetes type and indicated high levels of internal consistency reliability. Among participants with type 1 DM, the Cronbach α coefficient for the PedsQL total score was 0.88, with coefficients for the subscale scores ranging from 0.73 to 0.89 (**Table 2**). For participants with type 2, the coefficient for the PedsQL total score was 0.85, with coefficients for the subscale scores ranging from 0.71 to 0.90. The Cronbach α coefficients did not vary substantially by age group or sex within each diabetes type, and all met the cutoff of 0.70 for acceptable scale/subscale reliability as outlined by Varni and colleagues.[27]

In examining the mean PedsQL total and subscale mean scores by diabetes type (Table 2), HRQOL was found to be significantly higher (better) for youths with type 1 DM compared with those with type 2 on all total and subscale measures.

Multiple linear regression models were next used to examine the simultaneous effects of the demographic and diabetes-related variables on the PedsQL total score by diabetes type (**Table 3**). For youths with type 1 DM, lower overall HRQOL was associated with receiving Medicaid or another government-funded insurance program as opposed to private insurance ($P = .02$). There was also a significant age × sex interaction such that, in older groups, PedsQL scores were lower for girls but higher for boys ($P = .004$). The PedsQL scores were also higher (better) for those using an insulin pump compared with those participants who injected insulin, with an HbA_{1c} level of less than 9%, no comorbid conditions, 1 or fewer emergency department visits in the past 6 months, and no hospitalizations in the past 6 months. Race/ethnicity, parent education, duration of diabetes, and BMI were not significant predictors of overall HRQOL in this sample.

For the participants with type 2 DM, few covariates were significantly associated with their HRQOL. Injecting insulin at least 3 times a day compared with taking an oral medication or no medication for diabetes ($P = .03$) was significantly associated with better HRQOL, whereas 2 or more emergency department visits in the past 6 months ($P = .04$) was significantly associated with reduced HRQOL. The demographic variables, duration of diabetes, HbA_{1c} level, BMI, comorbid conditions, and complications were not significantly associated with HRQOL in this model.

Because the age × sex interaction was not significantly associated with the total PedsQL score among participants with type 2 DM, additional analyses stratifying by sex were completed. Longer duration of diabetes was associated with better overall HRQOL among the boys ($P = .04$), whereas 2 or more emergency department visits compared with none ($P = .03$) were associated with lower overall HRQOL among the girls. No other variables were significantly associated with overall HRQOL by sex.

Similar regression models were examined to investigate the associations of the demographic and clinical variables with the subscale scores of the PedsQL by diabetes type. Among youths with type 1 DM, the results generally mirrored those for the model examining the PedsQL

Table 3. Multiple Linear Regression of the Association of Demographic, Clinical, and Diabetes Management Variables With the Total PedsQL Score by Diabetes Type[a]

	Type 1 DM		Type 2 DM	
Demographic Characteristics	β Coefficient	*P* Value	β Coefficient	*P* Value
Sex				
Female	5.18	.02	15.35	.21
Male	1 [Reference]		1 [Reference]	
Race/ethnicity				
American Indian	2.26	.46	1.71	.66
Asian or Pacific Islander	−0.55	.76	−4.73	.36
African American	−0.27	.81	0.68	.83
Hispanic	−0.23	.79	−1.02	.76
Non-Hispanic white	1 [Reference]		1 [Reference]	
Parent education				
< High school graduate	0.79	.60	−2.40	.49
High school diploma	−1.32	.10	−0.19	.95
Some college or technical school	−0.55	.38	−2.49	.39
≥ Bachelor's degree	1 [Reference]		1 [Reference]	
Insurance				
None	−1.08	.59	−1.58	.76
Other	−0.58	.79	2.42	.58
Medicaid or other government-funded program	−1.95	.02	−3.48	.17
Private insurance	1 [Reference]		1 [Reference]	
Age of participant at clinic visit	.33	.003	0.21	.72
Age × sex interaction				
Female	−0.43	.004	−1.12	.11
Male	1 [Reference]		1 [Reference]	
Duration of diabetes, mo	−0.001	.85	0.07	.19
Diabetes treatment				
Oral or no diabetes medication	−5.14	.17	1 [Reference]	
Insulin < 3 times/d	−2.99	<.001	3.09	.23
Insulin ≥ 3 times/d	−2.80	<.001	7.01	.03
Insulin pump	1 [Reference]		−10.72	.30
HbA_{1c} level, %				
< 7	2.53	.009	2.77	.31
7-9	1.42	.02	−0.71	.80
> 9	1 [Reference]		1 [Reference]	
BMI *z* score	−0.52	.10	−1.04	.40
No. of comorbid conditions				
None	1 [Reference]		1 [Reference]	
1	−2.19	<.001	−2.56	.26
2	−4.53	<.001	−4.20	.18
≥ 3	−7.26	.02	−5.17	.36
No. of hypoglycemic episodes in past 6 mo				
None	1 [Reference]		1 [Reference]	
1	1.75	.11	1.50	.82
≥ 2	−1.68	.15	−6.61	.51
No. of ED visits in past 6 mo				
None	1 [Reference]		1 [Reference]	
1	−0.008	.99	−1.51	.63
≥ 2	−5.09	<.001	−6.62	.04
No. of hospitalizations in past 6 mo				
None	1 [Reference]		1 [Reference]	
1	−3.74	.005	−3.27	.50
≥ 2	−4.99	.03	4.54	.29
Multiple correlation coefficient	$R^2 = 0.09$		$R^2 = 0.19$	

Abbreviations: BMI, body mass index; DM, diabetes mellitus; ED, emergency department; HbA_{1c}, hemoglobin A_{1c}; PedsQL, Pediatric Quality of Life Inventory.
[a] All demographic, clinical, and management-related variables were entered into the models simultaneously.

total score, with some distinct differences (**Table 4**). Having fewer comorbidities, emergency department visits, and hospitalizations in the past 6 months were all significantly associated with better HRQOL across all PedsQL subscales. Using an insulin pump was associated with better HRQOL in all subscales except for school functioning. Having no insurance was associated with worse emotional functioning ($P = .01$), and having a primary insurance source of Medicaid or another government-funded program was associated with reduced school ($P = .003$) and psychosocial ($P = .03$) functioning compared with those who had private health insurance. A higher BMI *z* score

Table 4. Multiple Linear Regression of the Association of Demographic, Clinical, and Diabetes Management Variables With the Total PedsQL Score for Participants With Type 1 Diabetes Mellitus[a]

	PedsQL Subscale									
	Physical Health		Emotional Functioning		Social Functioning		School Functioning		Psychosocial Health	
Demographic Characteristics	β Coefficient	P Value	β Coefficient	P Value	β Coefficient	P Value	β Coefficient	P Value	β Coefficient	P Value
Sex										
Female	6.62	.004	2.89	.40	3.50	.22	6.96	.03	4.42	.08
Male	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Race/ethnicity										
American Indian	4.26	.17	−1.63	.73	−1.99	.61	7.98	.06	1.19	.73
Asian or Pacific Islander	−1.00	.59	0.30	.92	1.03	.67	−0.96	.71	−0.19	.93
African American	0.32	.78	−1.44	.40	−0.16	.91	−0.24	.87	−0.59	.64
Hispanic	−0.44	.62	−1.22	.36	0.07	.95	0.79	.52	−0.13	.89
Non-Hispanic white	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Parent education										
< High school graduate	0.79	.61	0.86	.71	1.16	.55	0.43	.84	0.77	.65
High school graduate	−1.84	.03	−0.66	.59	−0.60	.56	−1.58	.17	−1.03	.26
College or technical school	−1.21	.06	<−0.01	.99	−0.06	.94	−0.35	.69	−0.17	.81
≥ Bachelor's degree	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Insurance										
None	−1.68	.42	−7.94	.01	1.02	.69	4.63	.11	−0.77	.74
Other	−1.08	.62	−0.38	.91	0.02	.99	−0.53	.86	−0.30	.90
Medicaid or other government-funded program	−1.67	.05	−1.25	.33	−1.65	.12	−3.57	< .001	−2.09	.03
Private insurance	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Age of participant at clinic visit, y	0.61	< .001	0.10	.51	0.51	< .001	−0.06	.69	0.19	.13
Age × sex										
Female	−0.66	< .001	−0.52	.02	−0.16	.42	−0.26	.22	−0.31	.07
Male	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Duration of diabetes, mo	−0.01	.05	<−0.01	.63	<−0.001	.94	0.02	.02	0.004	.52
Diabetes treatment										
Oral medication or none	−3.63	.35	−1.55	.79	−8.81	.07	−7.41	.17	−5.98	.16
Insulin < 3 times/d	−2.79	< .001	−3.94	.001	−3.53	< .001	−1.94	.08	−3.11	< .001
Insulin ≥ 3 times/d	−2.70	< .001	−3.58	<.001	−3.71	< .001	−1.34	.17	−2.87	< .001
Insulin pump	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
HbA_{1c} level, %										
< 7	0.59	.55	4.20	.005	0.38	.76	6.20	< .001	3.58	.001
7-9	0.18	.79	2.21	.02	−0.60	.46	4.81	< .001	2.10	.003
> 9	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
BMI *z* score	−0.28	.38	−0.12	.80	−1.05	.01	−0.76	.09	−0.64	.07
No. of comorbid conditions										
None	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
1	−2.25	< .001	−2.74	.004	−1.92	.01	−1.74	.05	−2.12	.003
2	−3.76	.007	−6.18	.003	−4.32	.01	−4.30	.02	−4.95	.002
≥ 3	−5.86	.06	−7.40	.12	−1.99	.04	−11.29	.01	−7.92	.03
No. of hypoglycemic episodes in past 6 mo										
None	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
1	1.33	.24	2.86	.09	0.17	.90	3.23	.04	1.94	.12
≥ 2	−4.00	< .001	0.81	.65	0.54	.72	−2.48	.14	−0.42	.75
No. of ED visits past 6 mo										
None	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
1	0.50	.54	−0.72	.56	0.64	.53	−0.67	.55	−0.31	.76
≥ 2	−4.12	.004	−4.76	.03	−3.85	.03	−8.31	< .001	−3.47	< .001
No. of hospitalizations in past 6 mo										
None	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
1	−2.97	.03	−2.91	.15	−5.05	.003	−4.50	.02	−4.15	.006
≥ 2	−3.95	.01	−8.93	.01	−3.99	.18	−5.35	.11	−5.51	.04
Multiple correlation coefficient	$R^2 = 0.095$		$R^2 = 0.24$		$R^2 = 0.05$		$R^2 = 0.09$		$R^2 = 0.076$	

Abbreviations: BMI, body mass index; ED, emergency department; HbA_{1c}, hemoglobin A_{1c}; PedsQL, Pediatric Quality of Life Inventory.
[a] All demographic, clinical, and management-related variables were entered into the models simultaneously.

was significantly associated with worse social functioning ($P = .01$). Duration of diabetes was also significant for the school functioning subscale ($P = .02$); youths with a longer diabetes duration reported better functioning. In addition, there was a significant age × sex interaction for the physical ($P \leq .001$) and emotional ($P = .02$) functioning subscales, in that girls in older groups reported worse physical and emotional functioning than did boys in older groups.

For participants with type 2 DM, few variables were associated with the PedsQL subscale scores (results not shown), with the following exceptions. Having 2 or more emergency department visits compared with none ($P=.002$) and having 1 ($P=.03$) or 2 ($P=.02$) comorbid conditions compared with none were associated with worse physical functioning. Injecting insulin at least 3 times a day compared with taking oral medication was associated with better emotional functioning ($P=.04$), school functioning ($P=.03$), and psychosocial functioning ($P=.02$). In addition, diminished school functioning was related to being an Asian or a Pacific Islander compared with a non-Hispanic white participant ($P=.01$) and having had 2 or more emergency department visits in the past 6 months ($P=.04$). There was also a significant age × sex interaction ($P=.02$) in that girls reported worse physical functioning in older groups, whereas older boys reported better physical functioning. No other significant associations were observed.

To assess whether there was a relationship between the length of time since a participant had been diagnosed as having DM and that person's current age and sex, we also completed regression analyses using a 3-way interaction term (ie, duration of diabetes × sex × age) to predict the PedsQL total score by diabetes type. The 3-way interaction was not significant for either diabetes type (data not shown).

COMMENT

A major finding of this study was that youths with type 2 DM reported significantly lower HRQOL than did youths with type 1. The mean PedsQL total and subscale scores for both the participants with type 1 DM and those with type 2 were similar to those reported previously in other pediatric studies, which indicated lower HRQOL among children with chronic conditions, including diabetes, compared with healthy age-matched youths.[26,28,31] In our multivariable models examining associations between demographic and diabetes-related variables and the HRQOL of youths with type 2 DM, few significant associations were found, although the variance explained by the regression model for the youths with type 2 DM was higher than that for the youths with type 1. Only injecting insulin 3 or more times a day compared with using an oral medication and having fewer than 2 emergency department visits in the past 6 months were significantly associated with higher overall HRQOL. The use of injectable insulin was also associated with better emotional, school, and psychosocial functioning, suggesting that there is a strong psychosocial component to the type of treatment used by the participants. It is plausible that youths with type 2 DM who are taking oral medications and/or using dietary changes may experience less than optimal glycemic control, which could affect their psychosocial and physical functioning, as has been found in studies of youths with type 1 DM.[2,8,12,32] Greater flexibility in performing diabetes management at school may also be of importance.[33] These variables warrant further study.

Among youths with type 1 DM, better overall HRQOL was most strongly associated with having private health insurance, better glycemic control, and fewer comorbidities, as has been found in previous research.[12,20,21,34-37] Access to private health insurance could have afforded these youths more resources to better monitor and treat their condition, resulting in fewer diabetic complications and comorbidities. In addition, a higher BMI was significantly associated with poorer social functioning, similar to results in related studies.[38,39]

The interaction between age and sex, indicating that the girls' HRQOL was lower in older groups, whereas the boys' HRQOL was higher in older groups, was another notable finding. This interaction was significant for overall HRQOL and the emotional functioning subscale for the youths with type 1 DM and for the physical functioning subscale for the youths with type 1 DM and those with type 2. Duration of diabetes was also the only variable significantly associated with overall HRQOL for the boys with type 2 DM. These findings are important and complement other published reports.[21,34] As girls approach puberty and adolescence, they may experience more social pressures and self-consciousness, which may affect their life quality and management of their diabetes. Whereas boys may become more accustomed to the management activities that are associated with diabetes over time, the impact of puberty and adolescence may be more critical for optimal management for girls. Developing interventions to improve adolescent girls' comfort with and more rigorous management of their condition, with attention paid to their emotional health status, may be beneficial for their physical and psychological health.

Major strengths of the SEARCH Study are the large sample size, the extensive clinical information gathered in a standardized manner, the inclusion of youths with type 1 and type 2 DM, and the inclusion of multiple racial/ethnic groups, although no major differences by race were found in these analyses. A limitation of the study is the cross-sectional nature of the data, which precludes our ability to examine the effects of demographic and diabetes-related variables on HRQOL over time. We are also unable to examine temporal effects, such as whether the girls' HRQOL actually declines as they age, and conversely whether the boys' HRQOL improves over time. Further follow-up of this study cohort is ongoing, which will enable us to examine such research questions in future years.

The present study results suggest, however, that clinicians should be mindful of the potential quality-of-life detriments for youths after a diagnosis of type 1 or type 2 DM, particularly among adolescent girls. The patients' age, social environment, and financial resources; the type of treatment; and the severity of the condition affect the daily management of diabetes. Implementing supports in clinical practice to assist youths to better cope with and manage their diabetes has the potential to improve the HRQOL of pediatric patients.

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SEARCH for Diabetes in Youth Study

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